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## **THE INTEGRATED WASTE TRACKING SYSTEM A FLEXIBLE WASTE MANAGEMENT TOOL**

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### **ABSTRACT**

The US Department of Energy (DOE) Idaho National Engineering and Environmental Laboratory (INEEL) has fully embraced a flexible, computer-based tool to help increase waste management efficiency and integrate multiple operational functions from waste generation through waste disposition while reducing cost. The Integrated Waste Tracking System (IWTS) provides comprehensive information management for containerized waste during generation, storage, treatment, transport, and disposal. The IWTS provides all information necessary for facilities to properly manage and demonstrate regulatory compliance. As a platform-independent, client-server and Web-based inventory and compliance system, the IWTS has proven to be a successful tracking, characterization, compliance, and reporting tool that meets the needs of both operations and management while providing a high level of management flexibility.

**Keywords:** IWTS, Waste, Inventory, Compliance, Tracking, Management, Flexible

### **SCENARIO**

You are handed a memorandum stating that there is a change in the DOE Order 435.1 for Low Level Waste (LLW) management. Your regulatory engineer has highlighted one section of this order, which states, “all LLW must be dispositioned within 1 year”, effective in 9 months. As the LLW manager, you view this new requirement with very little apprehension. A phone call to the IWTS project team notifies them of the impending 435.1 change and within weeks, a change is made in the IWTS to track and notify personnel of the number of days any container of LLW has been in storage without final disposition. This report in IWTS is run by your LLW facility representatives each week as not only a reminder of the containers requiring action, but as a tracking method for you to status the progress.

Not long ago, this scenario would have had the INEEL LLW manager agonizing over the impending change. He would not have known how to implement a process to verify the above requirement because of complexities in inventory control such as repackaging, tracking of parent/child container relationships, valid genealogies trees, and other complexities related to waste inventory tracking. Luckily, here at the INEEL we have been able to create the Integrated Waste Tracking System, which not only tracks waste, but does much more. It is a flexible management tool, which brings waste management personnel together under one system to accurately and quickly track waste from cradle to grave. The IWTS is a powerful tool to help all functional groups perform their job with integration as a common thread.

## **WHAT EXACTLY IS IWTS**

IWTS, simply put, is a tool to manage containerized radioactive and hazardous waste as it moves through various Treatment Storage and Disposal (TSD) facilities toward ultimate dispositioning. It helps to manage waste throughout the entire lifecycle from waste declaration to disposal. This includes the tracking of waste during generation, treatment, storage, transport, and disposal. The IWTS provides all information necessary for facilities to properly manage and demonstrate inventory compliance with the Resource Conservation and Recovery Act (RCRA) regulations, DOE Order 435.1, State permits, and facility-specific Safety Analysis Report (SAR) requirements.

The IWTS is built around four fundamental functions: 1) characterization, 2) tracking (inventory), 3) compliance and 4) reporting. Three-tiered facility models (i.e., facility, unit/building, and grid x-y-z) are defined within the system to represent the appropriate hierarchy of site-specific structures. All container characterization data resides within the IWTS. Shipments, processes (i.e., repackaging, incineration, compaction, etc.), and disposals are various tasks that are modeled.

To assist with meeting compliance issues, IWTS provides a mechanism for the review and approval of profiles, temporary accumulation area (TAA) and low-level waste (LLW) tracking, and physical, radiological, & chemical limit evaluations. Hand-held inventory tools (scanners) provide real-time, remote inventory analysis and verification.

Flexibility comes in many forms. The following discussions provide a snapshot into IWTS as it supports many functional groups here at the INEEL.

## **FLEXIBILITY**

### **People**

We have all heard the cliché, “People are our most valuable assets”. Nowhere is this axiom more true than in the use of IWTS. It is a core functional requirement that the IWTS application be user-friendly. After all, it is the people who manage waste, not the software. If a tool does not allow flexibility for groups of people to do their jobs, then it is of limited value. IWTS is an extremely user-friendly application that provides a great deal of flexibility in the myriad applications for which it was designed.

People from all areas of waste management need to communicate in order to get waste from generation to final disposition. The INEEL has several functional groups that interact with waste. Each provides an essential function in the disposition of waste. Whether you're the generator, waste generator services (WGS) representative, operations, packaging and transportation, or environmental reporting official, the same system is used. IWTS provides groups and individuals with authorizations to perform their particular functions, while preserving others' authorizations for the tasks they are required to perform.

Those who are responsible for the initial characterization of the waste being generated provide the initial input into IWTS. Each as his or her own IWTS account allowing them to input the initial information through several characterization screens provided by the IWTS software. After the initial information is entered into IWTS, the Waste Generator Services (WGS) group takes that information and provides the expertise necessary to complete the characterization (profile) of the waste. They are the ones who certify and review the waste profile and evaluate it against applicable waste acceptance criteria. Up to this point, no container information has been required. Waste characterization data is used as a prerequisite to the container characterization (profile).

Container profiles are created by associating a waste (material) profile, which describes the contents of the container. Physical data pertaining to the container is entered on the container profile screens in IWTS by the WGS group. A barcode is assigned to each container. Each barcode is generated as a unique identifier for each area following a prescribed format created by system waste operations personnel. Once a barcode is assigned to a container, that barcode is printed and attached to the container.

Operations personnel perform shipments. They are responsible for maintaining inventories and keeping waste containers in the correct storage and/or processing locations.

Packaging and Transportation (Traffic) personnel are the players who provide the transportation services and therefore need to review all information prior to accepting containers into a truck for transit. IWTS allows this group to see all pertinent information to allow speedy reviews for timely shipments. Hazardous waste regulations require that a Department of Transportation (DOT) manifest accompany any shipment. Through a simple Proper Shipping Name (PSN) builder, IWTS creates an entire manifest in less than one hour, compared to several hours when performed by hand.

Other miscellaneous groups of people are categorized as “management”. These people usually require “read-only” access for reports such as current inventories, amounts of waste generated, shipped, disposed of, as well as many other metrics.

IWTS provides a single source where virtually all waste information can be accessed, manipulated, stored and processed by all types of users.

## **Places**

With many facilities spread out over a wide geographical area, it is sometimes difficult to adhere to common acronyms, process waste the same way, and/or even describe buildings and rooms with a common language. IWTS uses a three-tier model to describe any facility. Some places use a name to describe only a building while others use a name to describe sections of a single high-bay area. IWTS is flexible enough to use a facility/unit/grid type model. Facilities within IWTS are usually a single entity like a laboratory, a manufacturing plant, or a processing facility. Units are typically buildings or can even be sub areas within the facility. Grids (X, Y, and Z) are usually refinements of the unit.

An INEEL facility that had to provide a detailed inventory of mixed waste used physical grids on the floor and walls to describe their storage locations. IWTS easily adapted to this arrangement by setting the unit to the building, and all three of its grids (X, Y, and Z) arranged as was listed within the building. Grid X became the row, grid Y became the column, and the grid Z became the height. Most facilities can be modeled in any manner desired. IWTS was designed to accommodate any type of physical arrangement encountered.

## **Characterization**

Characterizing the physical, chemical, and radiological attributes of an item can be an intimidating process. The process of facilitating and documenting these characteristics is performed with ease using IWTS. The user-interface provides all the information needed to input data. Input screens are divided into several groupings, or tabs, which help keep track of similar characteristics. Tabs such as Approvals, Environmental Protection Agency (EPA) codes, Isotopes, Chemical Characteristics, Marks & Labels, etc. are a few examples. The smart user interface ensures that users cannot inadvertently input EPA or Underlying Hazardous Codes (UHC's) information for straight low-level waste. The interface restricts the user from entering characters inappropriately. Date fields are used when dates are required, always forcing a common standard. The use of picklists and radio buttons assure the user that only prescribed descriptions and inputs can be applied. As new requirements come, they are easily added to the existing screens without hindering or destroying the fundamental characterization data. The use of table-driven data allows changes in reference tables to be made without difficulty thus keeping up to date on all compliance issues.

Waste generation estimates (projections) can be manually entered into IWTS for tracking future generation amounts. Authorized personnel can view actual amounts generated to compare against the estimates. Because actual waste generation numbers are quickly obtained from IWTS, developing pollution prevention and waste minimization estimates become easy.

## **Operational Tools**

It's been said: "a data management tool is only as good as the data feeding it". Without a method of getting accurate data into the system on time, IWTS would be of little use. IWTS incorporates additional tools to help get accurate data into the system in a timely manner.

The INEEL had several issues involving data entry, data quality, delays, and incorrect physical inventories. One problem the site had were the delays and inaccuracies associated with manual data entry. It would take up to several weeks before information, recorded on hand written paper, was entered into the system. Once the data were entered, inevitable errors were found which took the system administrator a great deal of time to correct. The fact that data entered into the database were in some cases delayed for days and even weeks meant that any database generated reports were always trailing the actual plant conditions. Data quality was difficult to maintain on a real-time basis. Actual inventories performed in the field, always proved the database to be less than 100%, indicating constant data inaccuracies.

Other problems were encountered concerning container labels. Container identification labels were handwritten making it very difficult to identify. A more reliable method of container labeling and identification was required for accurate inventory control. Barcodes provided the answer for speed and accuracy necessary to remedy the situation. Labels measuring 4" X 6" were applied to all containers with both the barcode and printed identification number. All that was needed now was a method of scanning the barcodes for input into IWTS. Because containers are stored in open areas inside and outside, it seemed reasonable that a "non-wired" solution was necessary for any type of scanning device. With the adoption of the Institute of Electrical and Electronic Engineers (IEEE) 802.11 standard for Wireless Ethernet in 1997, wireless hand-held scanning devices were chosen for the task of container identification. The IEEE 802.11 standard allows commercial use of radio frequencies in the 2.4 GHz range up to 0.5 watts without any license requirements from the Federal Communications Commission (FCC). This solution provides an easy setup into any facility inside or outside for hands free movement. Symbol Technologies<sup>1</sup> wireless hand-held devices were chosen for this task. See Figure 1.



**Figure 1 – Wireless Mobile Scanning Device**

Incorporating wireless hand-held scanners, the INEEL was able to narrow the time lapse between what is really happening in the field and what is reflected in the tracking system. IWTS has been able to bring a "near real-time" aspect to container tracking with the use of these scanning tools. Inventory time has been reduced by 30%, with much improved accuracy. Additionally, automatically generated reports from the system are now also produced to save time. Reports that would take up to a day to produce by hand now take only minutes to create.

Wireless hand-held scanner applications have led to improvements in productivity, data accuracy, emergency response, and near real-time tracking. These tools reduce data errors by taking the data entry straight to the source. Operators can now scan containers and are assured the container identification is accurate and that any information received directly from the database can be compared with the real, physical data in a near real-time manner. Emergency response has been enhanced since a user can immediately determine at the scene the contents of a spilled container and determine what emergency actions to take. Inventories are now performed with ease. With more accurate real-time data, auditors can visit facilities, request any type of data and obtain instant access to accurate information. IWTS continues to adapt to

today's increasing technological world of hand-held devices, wireless radio communications, and the use of barcode scanning capabilities.

## **Limit Compliance**

One of the most important features of IWTS is the ability to adapt to a changing world of regulatory compliance. Facilities typically have Safety Analysis Reports (SAR) describing the limits imposed to maintain a safe working environment, or environmental limits established through permits granted by the State. As new materials are produced or processed, these SAR or permitted limits are updated accordingly. IWTS has the ability to display duration or time limits and evaluate physical, chemical, and radiological inventory/quantity limits for any facility. Limits derived from facility SAR's, permits, and other limit criteria are entered into IWTS for each facility as necessary. Shipments cannot proceed until IWTS runs these limit checks against current facility inventories with no failures. Proposed inventories at another facility can be calculated prior to actual shipments. This allows managers to manage their facilities by checking if additional inventory can be accommodated without violating any limits. Years ago, fissile gram limits for a facility would take days to calculate based on new shipments. Today, all of these calculations are performed before any container moves. Notices of Violation (NOV's) have been all but eliminated in these areas.

Another compliance limit check performed by IWTS is the Performance Assessments (PA) for the INEEL's Subsurface Disposal Areas (SDA). These calculations simply determine the radionuclide inventory and compare against set, predetermined limits. This report provides objective evidence verifying compliance with the established PA limits.

Temporary Accumulation Areas (TAA) were areas that frequently had containers exceed the 90 day storage limit. IWTS was flexible enough to incorporate a timed clock against any container on site. Since the incorporation of the timed clock over a year ago, there have been no TAA NOV's recorded at the INEEL. Revised DOE 435.1 Order was easily accommodated as well by providing a one year clock on all LLW containers generated.

The flexibility of IWTS in the area of regulatory compliance has been one of the most rewarding benefits to the INEEL. Waste management compliance violations have been dramatically reduced since the creation of IWTS. In one year following site-wide deployment of IWTS, the INEEL recognized a sixfold reduction in environmental citations from the State.

## **Processes**

Waste takes on many forms. In an effort to reduce waste volume, reduce chemical toxicity, and reduce high levels of radionuclides, processes are performed to change the properties of raw waste. There are several types of processes used at the INEEL. Thermal processing, re-packaging, compaction and sizing are performed to reduce the physical volume of waste sent to disposal areas. Macro-encapsulation is performed to help stop unwanted migration of hazardous materials. IWTS was fundamentally setup to capture any process performed, keeping track of radionuclide partitioning (dividing the radionuclides among all daughter containers), container genealogies, and all secondary waste associated with the process itself. IWTS has been able to

accommodate new processes as they are started and existing processes as they are stopped. The partitioning of radionuclides has been a tremendous help when repackaging into many newly created containers. The accuracy of the methodology produces a very flexible tool used to keep track of all containers contents and their associated genealogies.

Sometimes a particular process is so unique that modifying the core IWTS is not practical. How does the IWTS tool support these applications? Process Specific Applications (PSA) are written separately as an attached application linking all pertinent IWTS data to and from the PSA. This has proven very useful at the INEEL. It allows the facility-specific processes to be custom built while maintaining a link to IWTS.

## **Reporting**

Before IWTS, multiple databases were used to track waste information from one facility to another. As a result, inconsistent reports were generated across the site. Each facility interpreted regulations, permits, and operational procedures slightly different than the next facility. The manpower expended to rectify the inconsistencies was considerable. Because IWTS brought most facility waste tracking databases under one roof, reporting was finally done in a consistent format. With reports being only as good as the data available, the only challenge left to address was that of data quality.

Reporting, as a job function, can be simultaneously rewarding and frustrating. It can be rewarding when data is readily available and queries can be quickly generated that provide an exact match to the question at hand. However, frustration rises exponentially when the data is not available, the data is wrong, or the report generated does not answer the question asked. The INEEL has gone through all of the above situations but is beginning to see that most all of the necessary data requested is now readily available and that the data quality is very good. IWTS has been one of the single most important contributors to resolving the data quality issues. Because IWTS was built around an operational philosophy, the data input into the system is provided in a near-real time sequence providing up-to-date reports. The methodologies used for data entry, i.e. barcode scanners and smart, user friendly data input screens, have all contributed to the preparation of reports with vastly improved data integrity.

Reports in IWTS are divided between the following groups: Operational, Contractor Management, Regulatory Compliance, and Ad hoc reporting.

Operational reports usually change based on requests from the users of the system. They include such items as inventories, facility-specific limit compliance, TAA management, LLW tracking, and others. TAA management is as simple as pressing a button. A report showing the number of days in storage is displayed along with any items approaching their 90 day limit. With new RCRA rules imposed on waste management especially for universal accumulation areas, IWTS can easily adapt to changing time frames whether it be 90 days or 1 year. The performance assessment calculations were added recently at the request of operations personnel. It was simply a matter of determining the requirements from the user(s) and then creating the report. These types of reports support operations and the management of their facilities. IWTS is very flexible in this area because the necessary data is already there.



Contractor Management requires various reports to satisfy the DOE and the State. The INEEL continually get requests from both parties, ranging anywhere from current inventories at a particular facility or building to amounts of waste stored or disposed between certain dates.

Regulatory reports are mandated by the state, the local DOE office, RCRA, Toxic Substances Control Act (TSCA), EPA, the site treatment plan (Consent Order), and other DOE sites. Each agency describes their requirements through their manuals, orders, and other regulatory documents. Given these documents as our requirements, IWTS produces standard regulatory reports that have been certified, verified & validated (V&V). These reports are easily modified to suit requirement changes.

Ad hoc queries are performed on a daily basis. Customers come from all over. Managers, generators, waste specialists, packaging and transportation personnel, and a whole host of other groups find data within IWTS not only necessary for their job but also very useful for keeping communication channels open between different groups working together to get waste dispositioned. The data structure developed for IWTS was developed in such a manner that with a little knowledge of the system itself, these ad hoc queries (reports) are as flexible as any question asked.

An IWTS web server, accessible to all personnel within the company intranet firewall with or without an IWTS account, is also utilized supplying canned reports and some minimal ad-hoc reports. These reports serve to provide quick responses for people who are not intimately familiar with IWTS but still have a need for information. Standard web browser screens provide easy navigation to a menu of reports. Reports such as current inventory, container information, profiles awaiting approvals, generated waste totals, etc., are a few examples of the type of reports available. Emergency response crews can quickly access the site intranet, access the IWTS home page, find the container information report entering the applicable barcode, and determine the contents of any container that may be in question. With this information readily available from virtually any place on site, emergency response teams can quickly determine critical corrective actions.

Because of the constant operational handling of waste and the reporting visibility to all IWTS customers, IWTS hard copies (printouts) kept for quality control, were practically obsolete the minute the documents were printed. Audits found that the hard copies maintained in files were not always aligned with the actual database itself. The question of “which is the record copy?” was asked repeatedly. Knowing that the true “record” was always the electronic copy, IWTS underwent an improvement to make the data withstand audits as “the” quality record following requirements found in several documents listed in the references section (1-5). These documents provided the guidance needed to allow IWTS to be a fully recognized quality record (QR) system. After the software was modified to allow any field to be set as recordable, decisions were made by a steering committee as to which fields in the system required “quality status”. Once these fields had been identified and agreed upon, any change made to a profile after that profile had been fully approved got recorded in a log file accessible to anyone for review. The “before” and “after” information was recorded along with a reason for the change, the user, date and time. If changes being made were extensive, or changed the whole intent of the profile, the

quality record function would force the user to create a completely new profile requiring a complete review and approval cycle. An example of such a change would be to declare an existing low level waste as mixed low level waste. The fact that IWTS could be modified to support a quality record system, again demonstrates its flexibility as a tool to meet continual changes in the requirements that management and operations must meet.

## **USER INTERFACE**

Flexibility can only be accomplished if the tool being used is created with ease of expandability in mind. IWTS incorporates many of the features found in any modern graphical environment. The use of selectable preferences has proved invaluable when deploying IWTS to other sites and/or facilities. Some sites require approvals for intra-facility shipments while others do not. The ability to turn on and off features such as quality record status, password criteria, user profiles, automatically generated email notifications, annual approval requirements, and many more, allow IWTS to be adapted to practically any facility.

Notification of software updates is easily processed at the time of login. A message prompts the user that a new version of IWTS is available and provides a hot-link to the IWTS web page for download. Nothing is as easy for providing a complete installation of new software than clicking a button on a web page and having it fully install from the web. No formal knowledge of computers is necessary for this process. The fact that this system uses a client server relationship allows full processing within the facility where the operational work is accomplished. It also maintains complete duplication of data throughout the server network via bi-directional replication technology. This technology replicates all data from one server to the next providing high reliability to the overall system. If one server goes down, users can be “mapped” to any of the other functional servers. Waste operations do not stop. An additional server installed at that location with an existing network or telephone line easily performs expansion of IWTS to any other owned facility or outside company. It’s that simple.

## **CONCLUSION**

In order to be accepted and used, any tool created for an operationally based activity such as waste management, must complement the process. No tool will work if it is developed in an office environment with no interaction from the workers in the field. IWTS was designed from the bottom up with operations in mind. The success of IWTS can be attributed to the core philosophy that for any tool to provide continuous support, it must be flexible enough to adapt to a changing environment. Proof of this concept has been recognized from other sites at which IWTS has been deployed. Data loads from existing databases were very easy to map over. What makes IWTS a success is the flexibility which allows it to be adapted to the various waste management functions wherever it is deployed.

## **FOOTNOTES**

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<sup>1</sup> Symbol Technologies – SPT 2740 Pocket PC Scanner

## **REFERENCES**

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